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Forcing data at WRF lateral boundary corner and its impact on storm intensification – a case study through mid-latitude cyclone Christian

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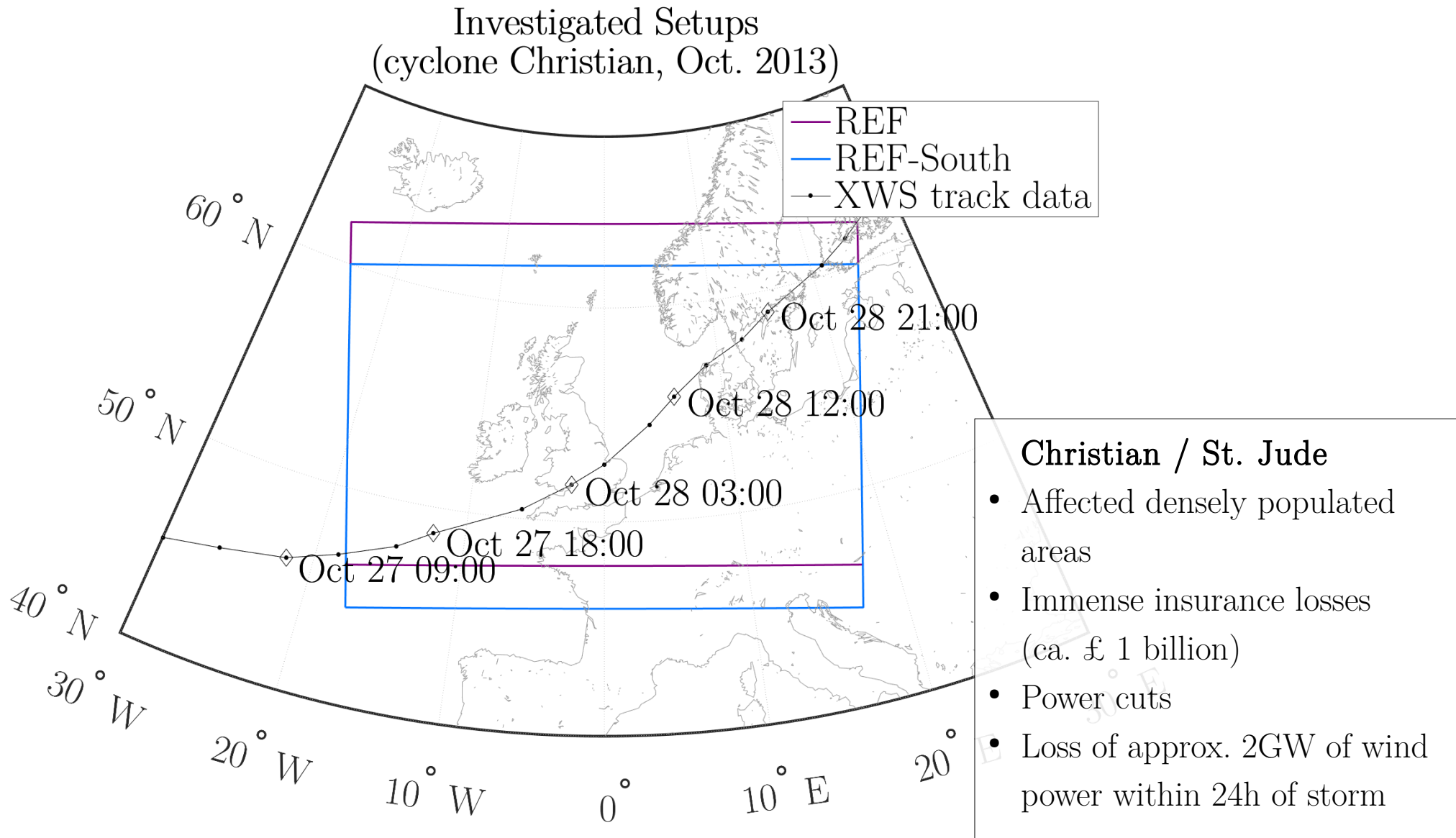
¹DTU Wind Energy, Technical University of Denmark, Roskilde, Denmark

14. June 2018

About me

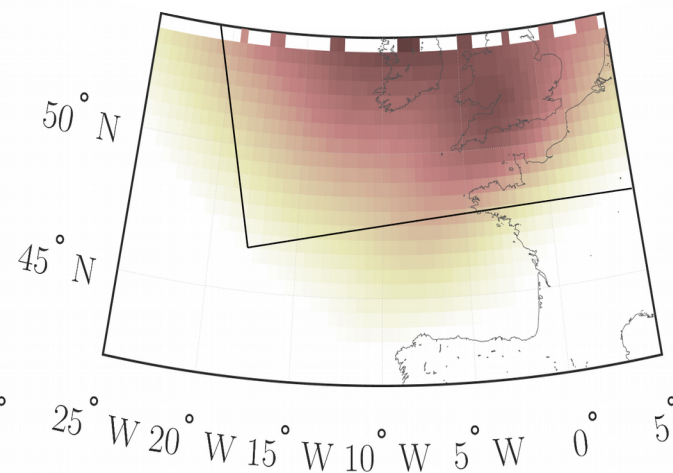
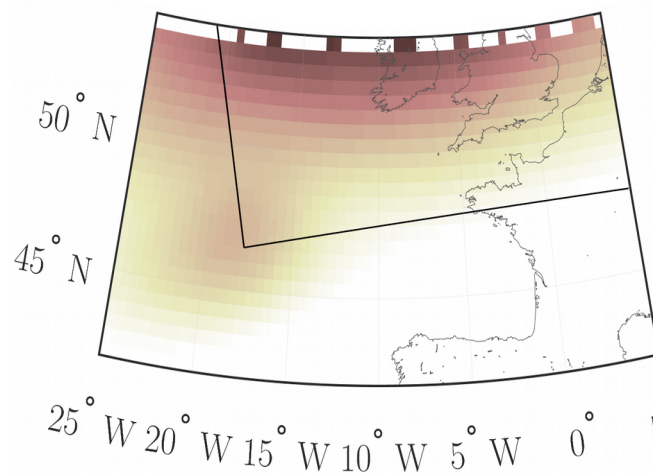
- 1st year PhD student (Sep. 2017), Technical University of Denmark (DTU Wind Energy)
“Advanced meteorological modeling across scales – MPAS for wind energy applications”
- Focus on mid-latitude storms influencing the North Sea
- Comparisons with currently used method (WRF nesting)

WRF “Corner Issue”: Motivation



Sea level pressure (SLP) field

Forcing data
(CFSv2)

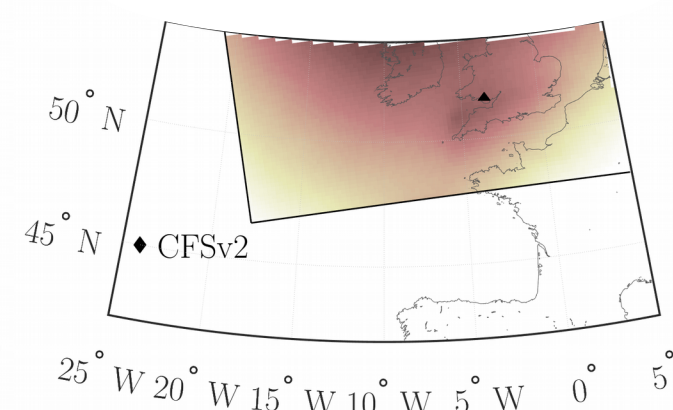
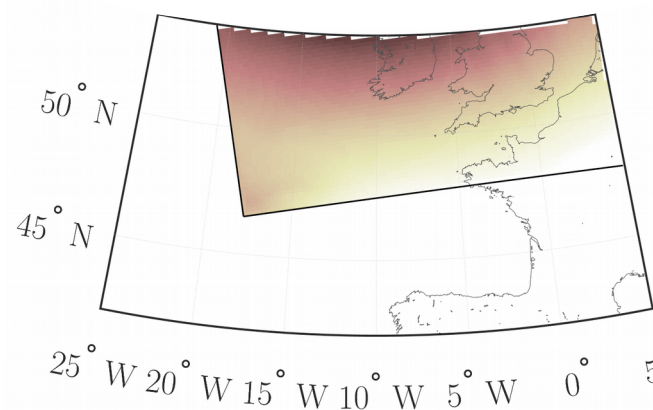


2013 Oct 27 UTC 1200

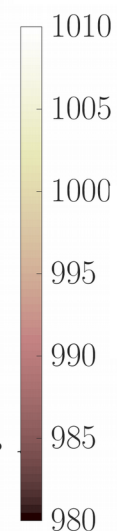
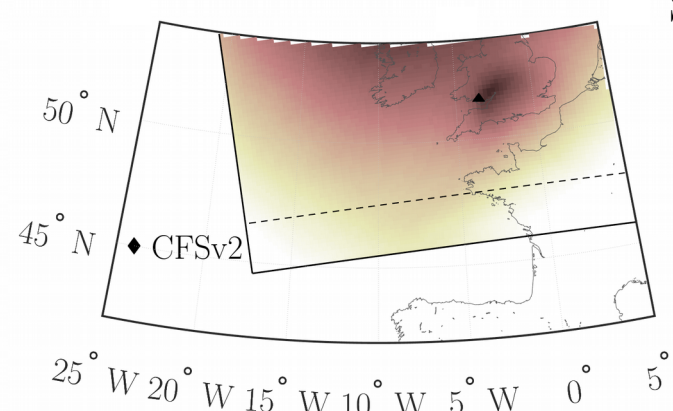
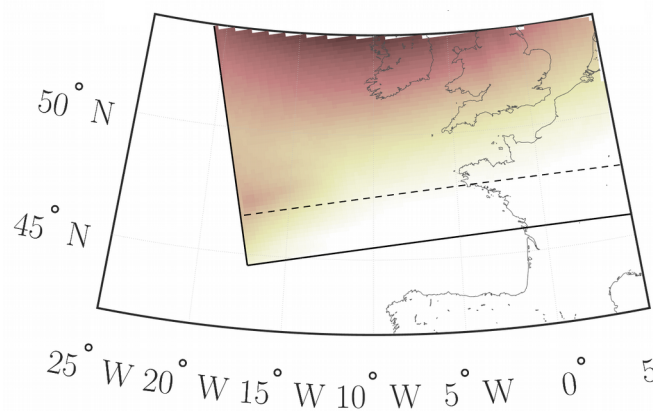
2013 Oct 28 UTC 0000

WRF (18km resolution)

- Reference



- Southwards shifted
domain



SLP [hPa]

Investigated Settings

Reference case	Applied changes
18km horizontal resolution	
51 vertical layers	
12h spin-up + 24h simulation time	
Forcing data: CFSv2	ERA5
6-hourly update	3-hourly, hourly
No nudging	Spectral and analysis nudging
4 layer relaxation zone	2 layer / 8 layer

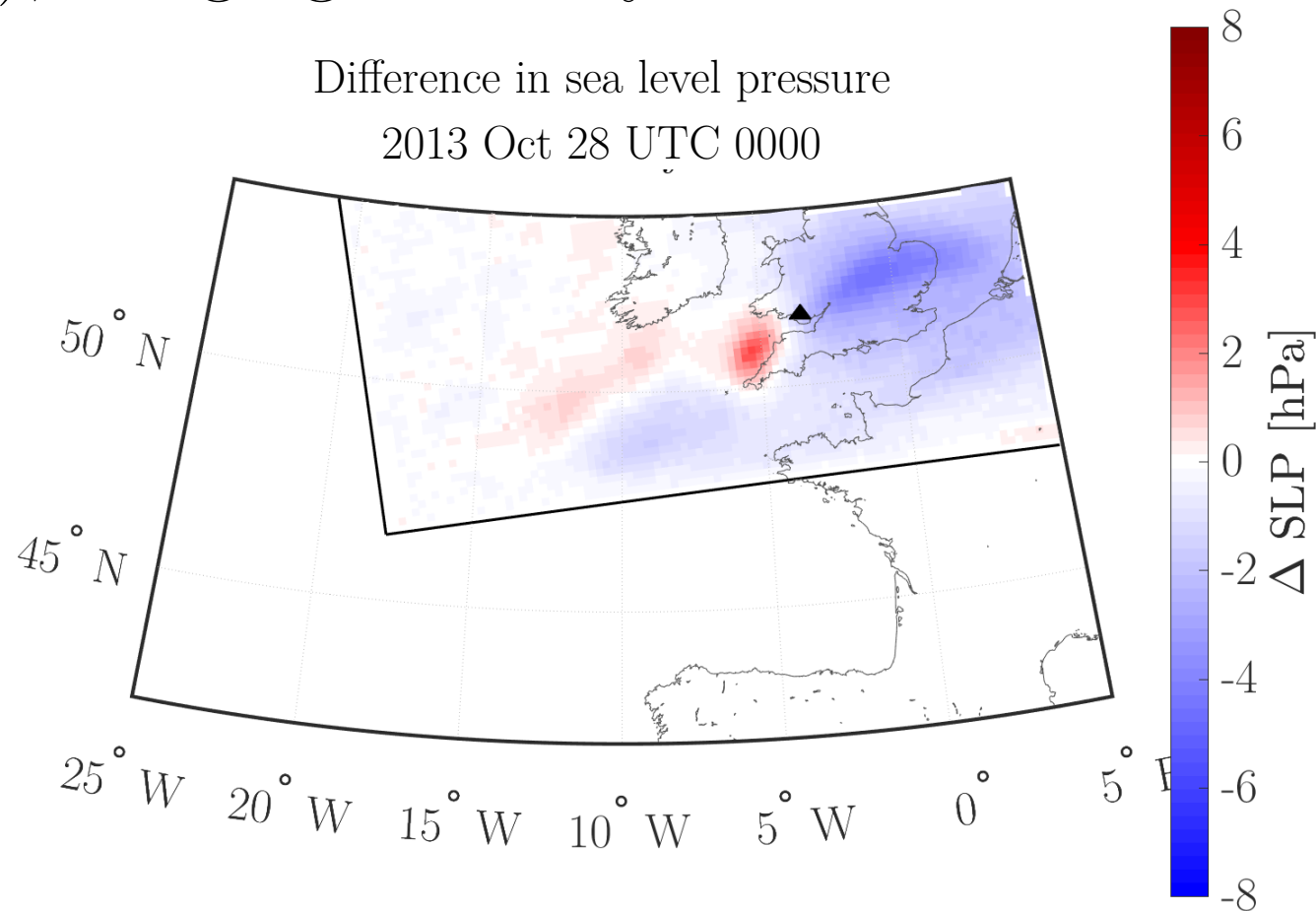
Physics: New Thompson (microphysics), RRTMG (radiation), MYNN (surface layer), Noah Land Surface Model (land surface), MYNN Level 3 (PBL scheme), Kain-Fritsch (cumulus)

Land cover: USGS (24 categories)

WRF version: WRF Model Version 3.7.1

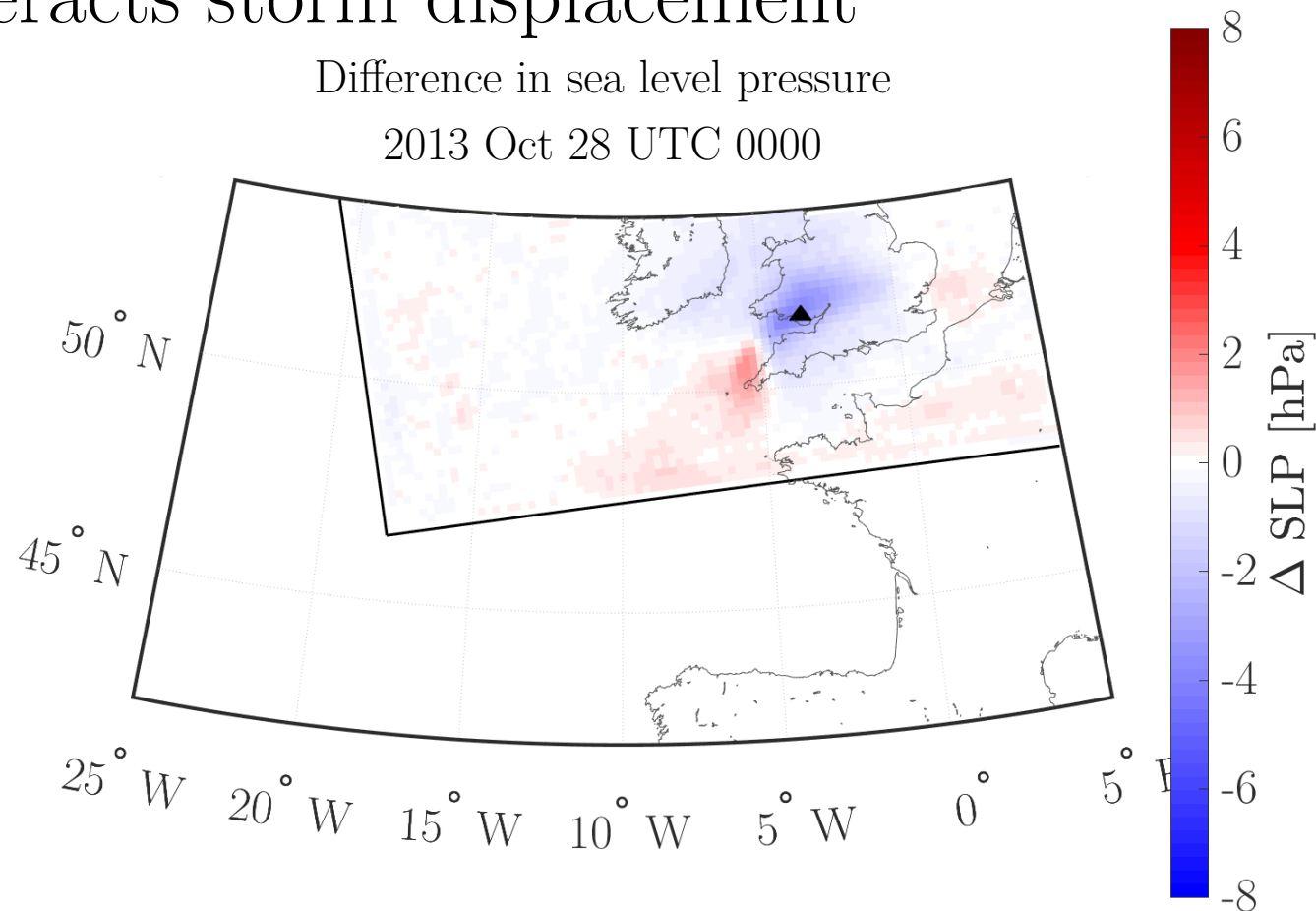
Results: Nudging

- Spectral nudging enhances storm intensity slightly
- Strongest: high wave numbers (nudging above 100km), nudging in all layers



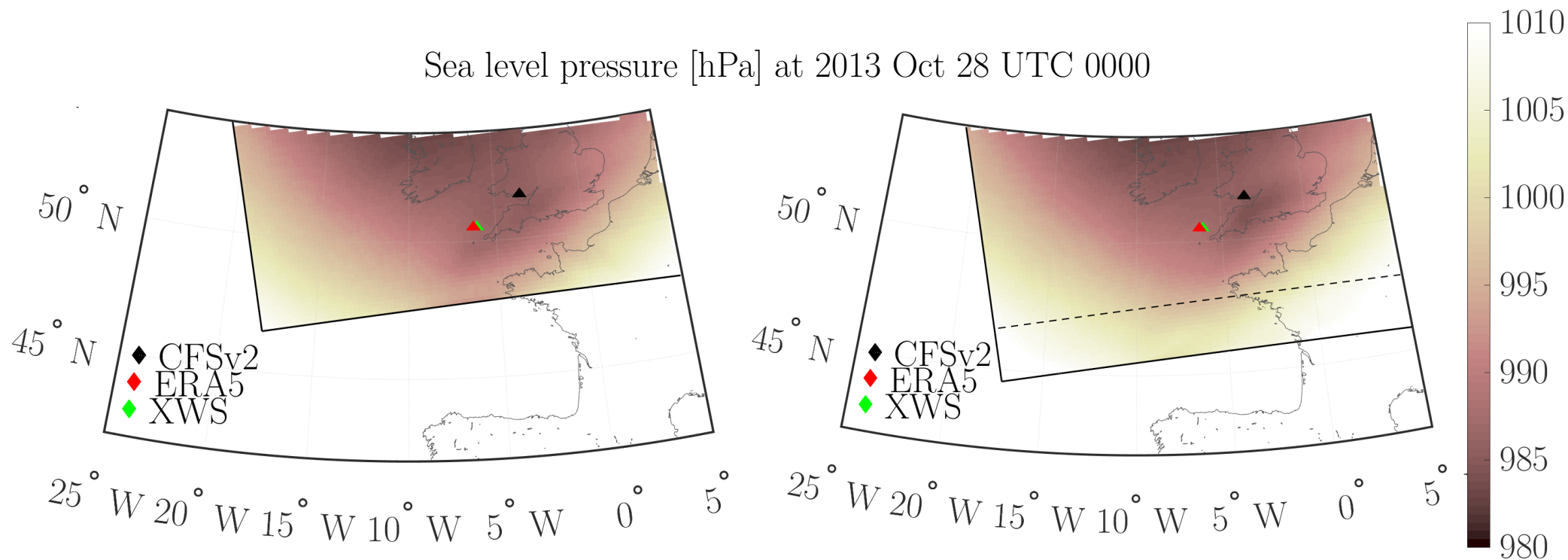
Results: Relaxation Zone

- Reduced relaxation zone brought biggest enhancement
- Surroundings of storm center less influenced
- Counteracts storm displacement



Results: Forcing Data Change

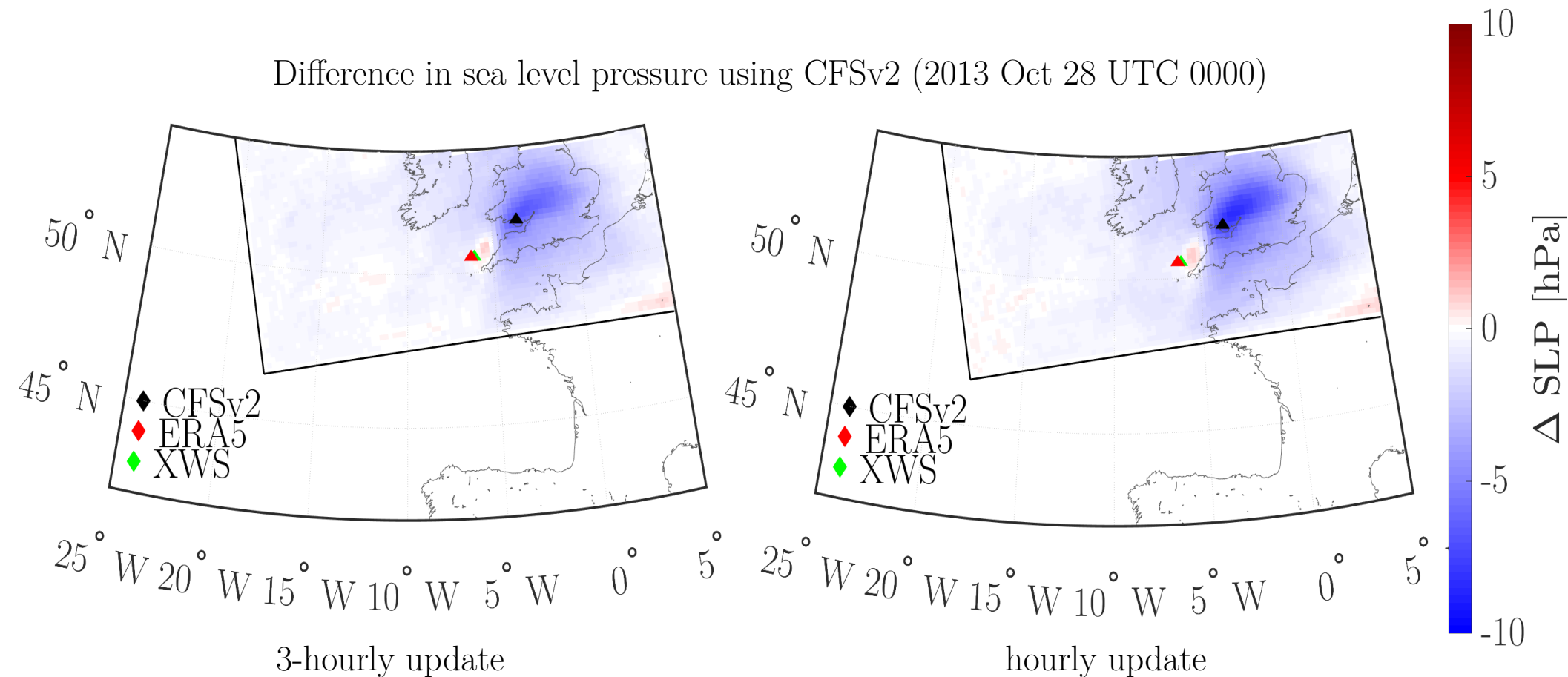
- Disagreement on storm location (at same time)
- Spec. nudging necessary in both domains
→ corner issue less pronounced
- No intensification



Results: Update Frequency

- Higher decrease of SLP in expected area and surrounding with increased frequency

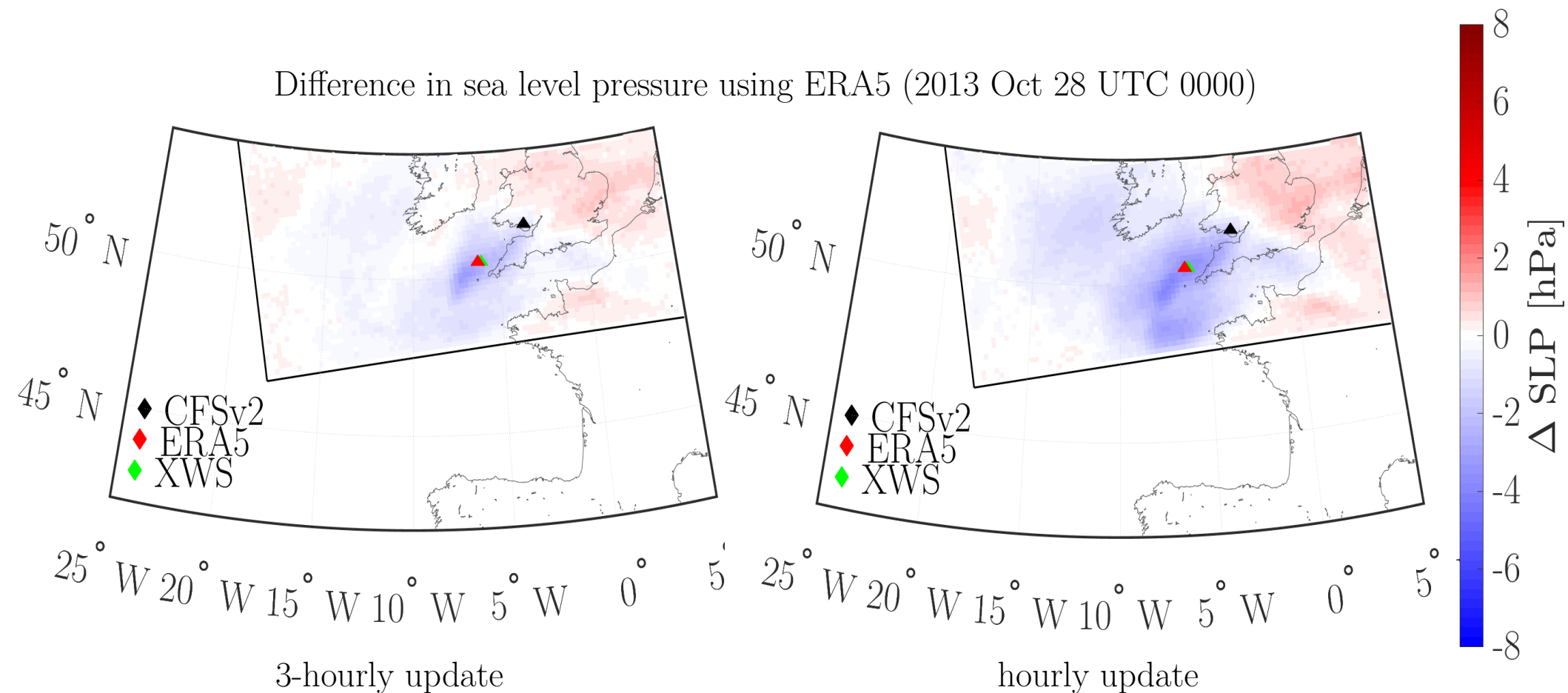
Difference in sea level pressure using CFSv2 (2013 Oct 28 UTC 0000)



Results: Update Frequency (Boundary Forcing)

- Enhancement also visible using ERA5
- Absolute decrease less pronounced

Difference in sea level pressure using ERA5 (2013 Oct 28 UTC 0000)



Conclusion

Approach	Effect on storm location	Effect on storm intensification
Reference	Displacement of storm center	Marginal intensification
Nudging technique	Corrected location	Moderate, also in surroundings
Relaxation width	Corrected location	Weak, concentrated on storm center
Forcing data	different storm center location (at same time)	Not comparable without bias
Update frequency	Corrected location	Strong enhancement

- Methods tackle crucial points
 - (1) Correct information from large scale forcing
 - (2) Reduce smoothing effect
- Compromises
- Biggest improvement: Update frequency

Work in progress:

Plan:

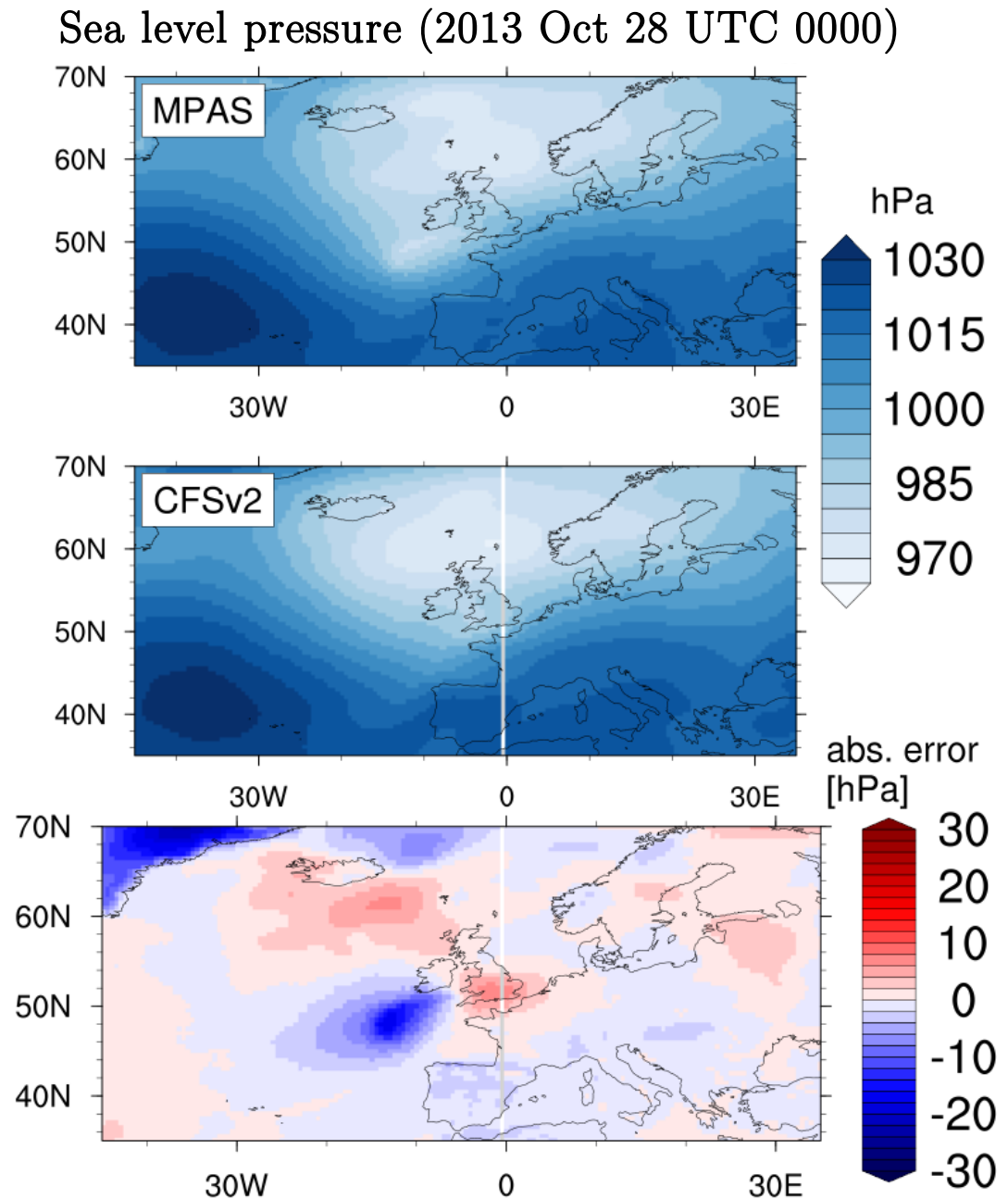
Run WRF with MPAS output
to test LBC update frequency of
30min and 10min

Current status:

Analysis of MPAS output

Faced issue:

SLP field: cyclone center



A satellite image of Cyclone Christian, a large tropical storm, over the Indian Ocean. The cyclone's eye is visible in the lower-left quadrant. A black outline map of the Indian subcontinent and surrounding regions is overlaid on the image. A semi-transparent grey rectangle is positioned in the upper-left, containing the word "Thanks!". A solid red horizontal line is located just above this rectangle.

Thanks!

XWS Extreme Wind Storm Catalogue

